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### Endogenous Social Security Financial Crises

Rodrigo Cerda

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**ENDOGENOUS SOCIAL SECURITY  
FINANCIAL CRISES**

**Rodrigo Cerda**

**Documento de Trabajo N° 250**

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# Endogenous Social Security Financial Crises

Rodrigo A. Cerda<sup>1</sup>

December 2002

## ***Abstract***

This paper addresses the causes and dynamics of pay-as-you-go social security financial crises. Its main hypothesis is there exists a self-reinforcing vicious circle between the social security system, the fertility rate and labor supply. We argue that changes in the pay-as-you-go social security tax rate may induce a subsequent demographic transition and a decline in supply of labor. These effects cause the system to be unsustainable, as fewer individuals pay social security taxes but more individuals receive social security benefits over time. A direct policy implication is that governments are required to adjust either the tax rate and/or the benefits of the social security system. Further, we show that when the government maintains its promised payments of benefits, the social security tax rate will follow a unit-root process that grows through time. We test our predictions concerning the fertility rate and labor supply by using the case of Chile as an experiment. The empirical analysis shows support for our hypotheses concerning fertility rate and labor supply. Later, we show evidence of a unit-root process in the social security tax rate by using data from a number of OECD countries.

JEL classification: H55, J13

Keyword: Social security financial crises, demographic transition

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<sup>1</sup> Department of Economics, Catholic University of Chile. Correspondence address: Casilla 76, Correo 17, Santiago, Chile; e-mail: [rcerda@faceapuc.cl](mailto:rcerda@faceapuc.cl), phone: (562) 354-7101, fax: (562)553-2377. I would like to acknowledge helpful comments from Mauro Alem, Luis H. Braido, Victor H. Lima, Larry Sjaastad and participants at seminars at the University of Chicago and Catholic University of Chile on earlier versions of this paper. The usual disclaimer applies.

## ***Introduction***

It is a well known that the pay-as-you-go (PAYG) social security systems of various countries around the world will run into severe funding crises in the future. As the PAYG systems become "unsustainable", social security benefits must be cut or tax rates must be increased to keep the system solvent. An example of a financial crisis in the PAYG social security is the case of Chile. Chile had a PAYG system from 1925 until 1981, when she switched to an obligatory individual account (IA) system. During the 1925-1981 period, the Chilean government levied social security taxes on the working population and used the proceeds to pay social security benefits to retired individuals.<sup>2</sup> The system resulted in fiscal problems as the number of elderly individuals receiving benefits increased over time while the number of individuals paying taxes remained fairly constant. Godoy and Valdes (1993) indicate that the number of individuals receiving social security benefits was 581,000 in 1970 but increased to over one million in 1979. During the same period, the number of individuals paying social security taxes increased from 2.2 million to only 2.4 million. As a consequence, the government continuously increased the social security tax rate. Figure 1 shows the evolution of social security tax for wage earners and salaried workers in the private sector of the economy. Both series show a persistent growth in the level of social security tax rates, with a decreasing trend occurring only during the five-year period prior to the 1981 change of the system. It is astonishing that both series reach levels exceeding 50 per cent during the 1970s!

[Insert Figure 1 about here]

A second example is Argentina, which had a PAYG social security system during a large part of the 20th century. In 1993 the Argentine Congress approved a social security reform law that transformed the system into an IA system similar to the one established in Chile. The tax rate in the old PAYG system also exhibited a rising pattern. In fact, the social security tax rate (contributions by employees and

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<sup>2</sup> See Godoy and Valdes (1993).

employers) was only 11 per cent of labor income in 1980 but rose to 27 per cent in 1993. The increase in the tax rate was fairly continuous over this period.<sup>3</sup>

This paper addresses the dynamics of the social security financial crises. One novelty of this paper is that it explains this phenomenon by extending previous results concerning the relation between social security, fertility and growth by Zhang (1995), Zhang and Zhang (1995, 1998), Erlich and Zong (1998) and Wigger (1999). In fact, common sense would indicate that as long as a demographic transition occurs, a funding crisis in the PAYG system might occur. In this paper we indicate that one of the causes of the funding crisis is a feedback effect from the social security to the demographic structure and the labor market. Our hypothesis is that the demographic transition becomes, to some extent, endogenous to the social security system such that whenever the social security system taxes labor income, labor supply will be negatively affected by the social security system. Those effects shrink the tax base and account for the unsustainability of the system.

In the paper, we provide a theoretical framework where households face a PAYG social security system that affects the fertility rate and labor supply. The main result of the paper is obtained by introducing the government's budget constraint into the analysis, and the effects of social security taxes over the fertility rate and labor supply. In this case, we are able to show that the tax rate follows a unit-root process because the introduction of the social security system shrinks the tax base and the government reacts by increasing the tax rate. In turn, the increase in the tax rate affects subsequently fertility rate and labor supply. This process produces a vicious circle between the tax rate and the fertility rate-labor supply decisions, one that magnifies any initial shock to tax rates.

An additional novelty of this paper is the empirical strategy that is developed. Firstly, we provide evidence of the effect of PAYG system on fertility and labor supply decisions. We test these predictions using the case of Chile as a natural experiment. The 1981 Chilean reform law required individuals entering to the labor force to affiliate with the new IA system, but it allowed individuals already affiliated

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<sup>3</sup> See the Asociacion Internacional de Organismos Supervisores de Fondos de Pensiones (1996)

to choose between the PAYG system or the new IA system. In addition, a third set of individuals were allowed to choose whether to be affiliated or not with the social security system. Hence, after 1981 in Chile individuals could be affiliated with (1) the new IA system, or (2) the old PAYG system, or (3) not affiliated with any system. These properties of the Chilean case allow us to obtain estimates of the effect of the PAYG social security system by using as counterfactuals those individuals unaffiliated with the PAYG system. Since individuals might choose between social security systems, we developed an empirical strategy that allows us to deal with self-selection.

We also test the hypothesis concerning the unit-root process in social security tax rates using a panel of OECD countries for the 1970-1999 period. Whether analyzed as a panel or as individual countries, we could reject the fact that the social security tax rate has a root lying outside the unit circle and thus we could reject the hypothesis that the PAYG social security tax rate follows a unit-root process.

The remainder of this paper is developed in the following way. Section I provides the theoretical framework of the paper. Section II focuses on the government's behavior and implements the family's reactions to the PAYG social security system. Section III tests the predictions by focusing on the Chilean experience; it describes the data set, the empirical strategy and the results. Section IV describes the panel of OECD countries used to analyze the existence of a unit-root in the social security tax level and discusses the results. Section V concludes the paper.

## ***I. The Environment***

We now turn to the economic environment of this paper. In the model to be developed, we assume that individuals rationally choose their labor supply and the number of children they bring up, causing the demographic transition to be endogenous. We also assume an overlapping generation model in which individuals live for two periods of time. During the first period they work and in the second they are retired from the labor market. Individuals obtain utility from consumption and leisure during the working period,  $c_t^l$ ,  $l_t$ , consumption during retirement age,  $c_{t+1}^l$ , and the number of children they decide to

bring up,  $n_t$ . In the notation a subscript indicates time while a superscript in the consumption variables indicates the generation to which the individual belongs.

The welfare of an individual at time  $t$ ,  $W_t$ , depends upon its current utility derived from consumption, leisure, and children, plus the utility of its representative child, as in equation (1):

$$W_t = u(c_t^t, c_{t+1}^t, l_t, n_t) + \delta W_{t+1} \dots (1)$$

where  $\delta$  is a parameter measuring altruism and  $W_{t+1}$  is the utility of the representative child. We use the same notation for the child's utility as for the parents because in period  $t+1$  the representative child faces the same problem as did the parents in period  $t$ . We will assume that  $u(c_t^t, c_{t+1}^t, l_t, n_t)$  is strictly increasing and separable in its arguments. These properties will simplify the analysis.

We next describe the budget constraint. There are two sources of income during the individual's lifetime: (1) labor income while working, and (2) a social security pension received during retirement. It should be noted that, since individuals value their leisure and face a time constraint (let the time constraint be equal to one unit of time), labor supply during the working period is endogenous. Also, we assume that individuals contribute to the social security system during adulthood by paying a fraction  $\tau_t$  of their labor income while receiving a return  $\theta$  on those contributions when retired. Thus total labor income is  $w_t(1-l_t)(1-\tau_t)$ , where  $w_t$  is wage rate per unit of labor supplied, and social security income is  $\theta w_t(1-l_t)\tau_t$ . Concerning the cost of bringing up children, we assume that it is an increasing function of the number of children,  $\eta(n_t)$  where  $\eta_n > 0$ . Finally, we assume that there is a perfect capital market, which allows us to write the budget constraint as in equation (2):

$$c_t + \frac{c_{t+1}^t}{1+r_{t+1}} + \eta(n_t) = w_t(1-l_t)(1-\tau_t) + \frac{\theta w_t(1-l_t)\tau_t}{1+r_{t+1}} \dots (2)$$

where  $r_{t+1}$  is the capital market interest rate at  $t+1$ . Using equation (2), the individual chooses  $(c_t^t, c_{t+1}^t, l_t, n_t)$  to maximize (1), given  $(\tau_t, \theta, w_t, r_{t+1})$ . Since the problem stated in (1) is recursive, combining (1) and (2), we may write the problem as in equation (3):



$$\max \sum_{t=0} \{ \delta^t u(c_t^t, c_{t+1}^t, l_t, n_t) + \lambda_t [w_t(1-l_t)(1-\tau_t) + \frac{\theta w_t(1-l_t)\tau_t}{1+r_{t+1}} - c_t^t - \frac{c_{t+1}^t}{1+r_{t+1}} - \eta(n_t)] \} \dots (3)$$

where  $\lambda_t$  is the shadow price of income at  $t$ . The associated first order conditions are:

$$u_1(c_t^t, c_{t+1}^t, l_t, n_t) = \lambda_t \dots (4)$$

$$u_2(c_t^t, c_{t+1}^t, l_t, n_t) = \frac{\lambda_t}{1+r_{t+1}} \dots (5)$$

$$u_3(c_t^t, c_{t+1}^t, l_t, n_t) = \lambda_t w_t [1 + \tau_t (1 - \frac{\theta}{1+r_{t+1}})] \dots (6)$$

$$u_4(c_t^t, c_{t+1}^t, l_t, n_t) = \lambda_t \eta_n(n_t) \dots (7)$$

As usual, these conditions equate marginal benefits with marginal costs for each of the relevant variables.<sup>4</sup> Equation (6) indicates that the marginal cost of leisure (its opportunity cost being labor income) depends in the social security tax rate. When  $\theta < 1+r_{t+1}$ , an increase in the tax rate is associated with a higher marginal cost of leisure, while if  $\theta > 1+r_{t+1}$ , the contrary holds. The intuition of this result is that, if  $\theta < 1+r_{t+1}$ , the present value of a dollar contributed to the social security from labor income is negative and thus an increase in the tax rate reduces the individual's net labor income. Conversely, when  $\theta > 1+r_{t+1}$ , the present value of a dollar contributed to the social security system is positive and thus an increase in the tax rate is similar to the effect of a wage subsidy.

Individuals determine their optimal consumption during adulthood and retirement, and their optimal labor supply and fertility rate by solving equations (2) and (4) – (7). This set of equations determines the following implicit functions:

$$c_t^t = c_t^t(\tau_t, \theta, w_t, r_{t+1}), c_{t+1}^t = c_{t+1}^t(\tau_t, \theta, w_t, r_{t+1}), l_t = l_t(\tau_t, \theta, w_t, r_{t+1}), \\ n_t = n_t(\tau_t, \theta, w_t, r_{t+1}), \lambda_t = \lambda_t(\tau_t, \theta, w_t, r_{t+1}) \dots (8)$$

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<sup>4</sup> Second order conditions are satisfied when  $u_{11}, u_{22}, u_{33}, u_{44} - \eta_{nn} < 0$ .

Using this implicit demand function, we will next state the main result of this section concerning the effect of an increase in  $\tau_t$  over the supply of labor and the fertility rate. To do so, and as a matter of notation, let  $\sigma = -u_{11}c/u_1$  be the coefficient of risk aversion (the elasticity of the marginal utility of consumption). The next lemma states the result:

**Lemma 1:** *When  $\theta < 1+r_{t+1}$  and  $\sigma < 1$ , the fertility rate and labor supply are negatively affected by an increase in the social security tax rate,  $\tau_t$ .*

Proof: Equations (4) to (7) can be written as:

$$\frac{u_1}{u_2} = 1 + r_{t+1}; \frac{u_3}{u_1} = w_t \left[ 1 + \tau_t \left( 1 - \frac{\theta}{1 + r_{t+1}} \right) \right]; \frac{u_4}{u_1} = \eta_n(n_t)$$

These conditions are the equality between marginal rates of substitutions and the ratio of prices that characterize the problem. Differentiating this marginal rates of substitution and the budget constraint with respect to  $\tau_t$ , we obtain equations (9) and (10):

$$\frac{\partial l_t}{\partial \tau_t} = \frac{w_t}{D_1} \left[ \frac{\theta}{1 + r_{t+1}} - 1 \right] [(1 - l_t) - \frac{\varepsilon}{\sigma}] \dots (9)$$

$$\frac{\partial n_t}{\partial \tau_t} = \frac{w_t}{D_1} \left[ \frac{\theta}{1 + r_{t+1}} - 1 \right] [(1 - l_t) - \frac{u_3}{u_{33}}] \dots (10)$$

where  $D_1 > 0$  and  $\varepsilon = (1 + (u_{44} - \eta_{nn})^{-1} u_{11} \eta_n^2 + (u_{22} (1 + r)^2)^{-1} u_{11}) > 1$  by second order conditions. Since  $\theta < 1 + r_{t+1}$ , then  $[\theta / (1 + r_{t+1}) - 1] < 0$ . Also note that  $(1 - l_t) - \varepsilon / \sigma < 0$ . To prove the claim, suppose that the contrary holds, thus  $(1 - l_t) \sigma > \varepsilon$ . But this is a contradiction since  $\varepsilon > 1 > \sigma$ . Hence  $(1 - l_t) - \varepsilon / \sigma < 0$  and  $\partial l_t / \partial \tau_t > 0$ . Similarly, as  $(1 - l_t) - u_3 / u_{33} > 0$ , we have  $\partial n_t / \partial \tau_t < 0$ . This result establishes the proof. Q.E.D.

The intuition of these results is as follows. Equations (9) and (10) show that the effects depend on  $\theta / (1 + r) - 1$ , which has two influences over the variables of interest. In the first place, since  $\theta < 1 + r$ , it determines a negative income effect associated with a higher tax rate. Secondly, it relates to changes in the relative price of leisure, as less income is obtained from a marginal unit of labor.

Equation (9) indicates the effect of taxes on labor supply. It includes the term  $[(1-l_t) - \varepsilon/\sigma]$ , which directly relates to an income and a substitution effect. As  $1-l_t$  is the quantity of labor supply, there is an income effect, and since  $\sigma$  measures the concavity of the utility function relating to consumption, there is a substitution effect. Note that  $\varepsilon$  is a measure of concavity in the utility function of variables other than leisure. As we assume  $\sigma < 1$ , the substitution effect dominates and therefore leisure decreases as the social security tax rate increases; individuals are willing to substitute consumption through time.

Equation (10) relates to the effect of changes in the tax rate on the fertility rate. It includes the term  $[\theta/(1+r) - 1][(1-l_t) - (u_3)(u_{33})]$ , which is unambiguously negative indicating that the income and the substitution effects have the same sign in connection with the fertility rate. The intuition is that fertility is a normal good and thus is negatively affected by the decline in income arising from an increase in the PAYG tax rate. The substitution effect arises because an increase in the tax rate reduces the net-of-tax wage received by workers and therefore decreases the marginal cost of leisure. Accordingly, workers switch resources towards leisure by decreasing fertility rate.

Summarizing, when  $\theta < 1+r$ , an increase in the social security tax rate is associated with a substitution and an income effect. In the first case, the social security system decreases the relative price of leisure, and thus negatively affects labor supply and fertility rate. Furthermore, the negative income effect of the higher tax rate produces an additional impact in fertility rate which unambiguously lowers that rate.

## ***II. The Dynamics of the Social Security Tax Rate***

In this section, we focus on the financial aspects of the social security system. We will demonstrate that when the fiscal budget is balanced, a PAYG social security system will endogenously face a financial crisis that leads to a continuous increase in the social security tax rate. We will focus on the case where the government maintains a balanced budget and pays, as long as possible, the social security benefits that it has promised. In this case, the social security tax rate is the instrument used to

equilibrate any potential imbalance in the government's budget. To illuminate the problem, we will provide a definition of a social security financial crisis in our economy. Later, we include our results concerning fertility rate and labor supply and we show that they will generate an endogenous financial crisis in any PAYG social security system.

***Definition 1:*** *A PAYG social security financial crisis will be understood as a situation in which the government increases the social security tax rate in order to obtain sufficient revenue to pay social security benefits that have been promised.*

We now turn to the government's budget constraint. As will be shown below, the fertility rate and the supply of labor are the key variables in the fiscal budget. In fact, their dependency in the current tax rate will induce a dynamic in the social security tax rate through time. We will focus in the fiscal budget at time  $t+1$ . Contributions to the system depend in total labor income,  $n_t w_{t+1}(1-l_{t+1})$ , and the social security tax rate  $\tau_{t+1}$  while benefits depend on past contributions to the system  $\tau_t w_t(1-l_t)$ , and the rate of return on those contributions. Thus, the government faces the following budget constraint at  $t+1$ :

$$n_t(\tau_t)\tau_{t+1}w_{t+1}(1-l_{t+1}(\tau_{t+1})) = \theta w_t(1-l_t(\tau_t)) \dots (11)$$

in which equation (11) uses the implicit demand functions determined by equation (8), but we have omitted all variables other than the tax rate, which is the variable of interest in the analysis. Note that we might write the government constraint as in equation (12):

$$\tau_{t+1}(1-l_{t+1}(\tau_{t+1})) = \frac{\theta}{G(\tau_t)} \tau_t(1-l_t(\tau_t)) \dots (12)$$

where  $G(\tau_t) = w_{t+1}n_t(\tau_t) / w_t$  is the rate of growth of "full" income. Subsequently we define  $G(\tau_t)$  as the aggregate rate of growth of the economy.

We will demonstrate in what follows that the social security tax rate must increase through time. To gain intuition concerning this result, note that a key role in the dynamics of the tax rate is played by the

difference between the rate of return of the social security system and the growth rate of the economy. To illustrate its importance, let us assume for the moment that labor supply is held constant, e.g.,  $1-l_t$  is constant. In this case, if  $\theta$  exceeds the aggregate growth rate of the economy,  $G$ , the tax rate increases continuously over time for any positive initial level of the tax rate (see equation 12). This case is similar to a unit root process for the social security tax rate, as any initial positive shock in the tax rate is magnified over time and hence the system is not sustainable even for a finite number of periods. The intuition of this result is quite obvious: total resources of the economy are growing at a lower rate than are the benefits that have been promised to retired individuals. In response, the government must raise the tax rate to collect additional revenue.

Next, consider the case when  $\theta < G$ . If the endogenous variables of the model were not disturbed by changes of the tax system, the government would be able to decrease the tax rate over time. Nevertheless, individuals choose variables which depend on  $\tau_t$ . As individuals react to the PAYG system, we will show that, even when  $\theta < G$ , the PAYG tax rate,  $\tau_t$ , must increase through time to generate the funds necessary to pay the social security benefits. To prove this result, note that equation (12) determines an implicit function where the tax rate depends on its lagged value, as in  $\tau_{t+1} = \tau_{t+1}(\tau_t)$ . This implicit function indicates the existence of dynamics in the social security tax rate. Using equation (12), we may compute the comparative statics of an increase  $\tau_t$  over  $\tau_{t+1}$  as<sup>5</sup>:

$$\frac{\partial \tau_{t+1}}{\partial \tau_t} \frac{\tau_t}{\tau_{t+1}} = \frac{1 - \frac{\partial l_t}{\partial \tau_t} \frac{\tau_t}{1-l_t} - \frac{\partial G}{\partial \tau_t} \frac{\tau_t}{G}}{1 - \frac{\partial l_{t+1}}{\partial \tau_{t+1}} \frac{\tau_{t+1}}{1-l_{t+1}}} \approx 1 + \left( \frac{-\frac{\partial G}{\partial \tau_t} \frac{\tau_t}{G}}{1 - \frac{\partial l_{t+1}}{\partial \tau_{t+1}} \frac{\tau_{t+1}}{1-l_{t+1}}} \right) > 1 \dots (13)$$

This expression is quite intuitive. It shows that the effect of a one per cent increase in the current tax rate is associated with an increase greater than one percent in the level of the future tax rate.

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<sup>5</sup> The approximation comes from  $\frac{\partial l_t}{\partial \tau_t} \frac{\tau_t}{1-l_t} \approx \frac{\partial l_{t+1}}{\partial \tau_{t+1}} \frac{\tau_{t+1}}{1-l_{t+1}}$ .

Therefore the PAYG tax rate follows a unit root process, as a shock to tax revenue is amplified through time. The intuition is that an increase in current tax rate must increase the future level of taxes because (1) current contributions to the system are larger (which implies that we must raise the future level of taxes to be able of paying future benefits) and because (2) future labor supply and fertility rate are negatively affected, as is indicated by the term  $(-\frac{\partial G}{\partial \tau_t} \frac{\tau_t}{G}) / (1 - \frac{\partial l_{t+1}}{\partial \tau_{t+1}} \frac{\tau_{t+1}}{1-l_{t+1}})$ . Note that  $-\frac{\partial G}{\partial \tau_t} \frac{\tau_t}{G} < 0$  represents the effect of the social security tax on the aggregate growth rate of the economy, which in turn depends upon the negative impact of social security tax on the fertility rate. Furthermore, since  $\frac{\partial l_{t+1}}{\partial \tau_{t+1}} \frac{\tau_{t+1}}{1-l_{t+1}} > 0$ , the effect of fertility rate is amplified by the negative impact in labor supply. In other words, an increase in the social security tax rate produces a lower fertility rate and these individuals work less intensively than did their parents. Those two elements reduce future social security tax revenues and hence the government must react by increase the future level of the tax rate in addition to the initial impact of the increase in the current tax rate.

We conclude that even when  $\theta < G$ , the elasticity of  $\tau_{t+1}$  with respect to  $\tau_t$  unambiguously exceeds unity and hence the tax rate follows a unit root process. The next lemma summarizes the finding:

***Lemma 2:*** *When  $\theta < 1+r_t$  and  $\sigma < 1$ , the social security tax rate follows a unit root process and increases continuously trough time.*

### **III. The Empirical Evidence**

We turn now to tests of the implications of the preceding analysis. We first use a micro data base containing data from Chilean individuals. We focus in the case of Chile because it provides a natural experiment which allows us to disentangle the effect of tax rate over fertility rate and labor supply.<sup>6</sup> The experiment occurs because the 1981 reform allowed the coexistence of three groups of individuals: (1)

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<sup>6</sup> Erlich and Zong (1998) provided evidence of the effect of social security system over fertility and human capital using a data base containing data across countries. Song (2000) provided similar evidence.

those affiliated with the PAYG system, (2) those affiliated with the new individual account system and (3) those unaffiliated with any social security system. This property of the Chilean reform allows us to disentangle the effect of the PAYG system by comparing the behavior of individuals affiliated with and unaffiliated with the PAYG system, where the later individuals are used as control group in our empirical analysis.

### **Self Selection and Exogenous Allocation in the Chilean Social Security System**

Chile introduced its first obligatory social security system in 1925. The system was initially implemented as a mixture between a typical non-funded system and a collective capitalization system. Taxes on workers were used to pay the pensions of retired individuals and any excess of funds were accumulated as a reserve for future expenditures.

Initially, funds from the reserve allowed the government to pay part of the benefits but ,as the number of retired individuals rose, the funds from the reserve continuously decreased and the system became a fully non-funded PAYG system. The system faced a large growth in the number of retired individuals, 209 per cent between 1961 and 1973, while there was only an increment in the number of workers of only 53.5 per cent during the same period. The government reacted by continuously raising the tax rate over time (see Figure 1). After 1973, however, the large increase in the tax rate was not enough to finance the system due to the unfavorable situation of the economy; the period 1973 to 1980 was characterized by a decline in the real wage rate and an increase in unemployment. Those two factors, plus the possible growth of evasion, reduced the revenues of the social security system to levels below those of 1972. As a consequence, in 1981 the Chilean government decided to reform the system and to implement a fully funded social security system through individual accounts managed by private institutions.

The 1981 reform of the Chilean social security system permitted the old non-funded PAYG system and the new IA system to coexist. The new system was obligatory for individuals entering the labor force for the first time after 1981, while individuals already working in 1981 were not required to

switch; they were able to choose between the PAYG and the new IA system. Also, there was a third group of individuals that were allowed to choose between affiliating with or remaining unaffiliated with the IA system; these were the self-employed individuals.

Individuals affiliated with the new system paid contributions of ten per cent of their labor income to private institutions (the AFP) that invested and managed those funds. The benefits they received upon retirement depended upon the financial return of the AFP's investments. The AFPs had to compete to obtain the financial investments from individuals.

The set of individuals remaining with the PAYG system were affiliated with four main institutions: the social security administration (SSA), the private worker pension administration (PRWPA), the public worker pension administration (PUWPA) and the armed forces pension administration (AAFFPA). Some other institutions also existed, but their size was smaller than those cited above. These institutions were later merged into a unique institution (the National Pension Institute, INP) that manages the government PAYG social security funds.

Almost 75 per cent of the individuals affiliated with the PAYG system at the beginning of 1981 (see Arellano, 1984) decided to switch to the new IA system during the first year of its implementation. One of the main determinants of this decision may have been the differential in the tax rates between the PAYG and the individual account system. In fact, individuals affiliated with the SSA (unskilled labor) have to pay 19.1 per cent of their labor income as social security tax. The PRWPA (skilled workers on the private sector) taxes their affiliates at 20.15 per cent while the PUWPA (public sector workers, excluding the armed forces) taxes their affiliates at 19.03 per cent of their labor income. The AAFFPA tax rate is 20 per cent. Thus the tax rate in the PAYG system was around 20 per cent of labor income, in contrast with the ten per cent rate in the IA system. The subsequent increment in the disposable income for those individuals switching to the new system may have been very influential on the overall switching to the new system.

Even though the tax differential provided an incentive to switch between systems, almost 25 per cent of individuals chose to remain in the old system. Why? We can provide some possible reasons.



A first element that might affect the decision to remain in the PAYG system was the way in which the benefits were determined. Benefits in the PAYG system usually are a fraction of the total wage income earned during the last five years prior to retirement. Accordingly, workers in the PAYG system have a strong incentive to obtain higher wages during the last part of their working life. In the new system, the individual has an individual account that earns interest over time, so workers have an incentive to work and accumulate pension funds throughout their working lives. In this scenario, older individuals that did not work hard enough during their working life prior to 1981 did not have an incentive to switch. On the other hand, an individual who was fairly young at the moment the law was passed was not negatively influenced by the change in the law as he or she had not already determined their working life strategy. The data seem to corroborate that hypothesis since 92 per cent of the affiliated aged 63 at the moment of the reform decided to remain in the old system while almost 100 per cent of those aged 28 or younger switched to the new system (see Figure 2).

[Insert Figure 2 about here]

Another set of incentives to remain in the PAYG system depends on the institution of affiliation. When comparing the level of pensions on the four main institutions of the non-funded system, we find that in 1980 the average pensioner of the SSA obtained only 46 per cent of the average Chilean pension, while individuals affiliated with the PRWPA obtained 77 per cent of the average and individuals affiliated with the PUWPA received 148 per cent of the average. In the case of the armed forces pension administration, the benefit was 350 per cent of the average Chilean pension. It should be noticed that there might be some self-selection in those data in the sense that workers affiliated with the SSA are unskilled workers, while the ones affiliated with the PRWPA are skilled and thus the difference in the pensions may be explained, at least in part, by differences in past contributions. However there is also some exogeneity in those benefits. Public sector workers are not quite different from private sector workers, and also people in the armed forces do not have larger wage incomes than do those in rest of the economy in general. This exogenous component of the difference in the level of pension may have had an impact on the decision concerning switching to the new pension system.

The above description has emphasized the self-selection that arose between social security systems. However, there were individuals that did not have the option to choose between systems. There are two sets of those individuals: (1) individuals who have not entered to the labor force when the law passed and who are obliged to affiliate with the new system as soon as they enter the labor market, and (2) individuals in the armed forces, who were required to stay with the PAYG system by the 1981 law.

In summary, Chile currently has individuals affiliated with the IA system, but also individuals affiliated with the old PAYG system and individuals unaffiliated with any system. Among those sets of individuals, self-selection arose for individuals who were currently working in 1981. However, there also are some individuals that could not choose between the systems and were exogenously assigned to the PAYG or the IA system.

## **The Data**

This paper uses the 1998 CASEN survey (Socioeconomic Characterization Survey of the Chilean Population) collected by the Chilean government during November and December of 1998. The survey is based on a random sample of 48,107 households with a probabilistic error of 0.45 per cent. There are 188,360 individuals on the sample. This survey has various parts containing information on schooling, health, housing, income, employment and demographic characteristics. There is a record for each individual.

Children: We computed the number of children in each household (a variable that was used to compare the effect of social security on the fertility rate) by computing the number of individuals who were a son or daughter of the head of the household in the survey. This measure has two potential problems: (1) children may leave a household to live by themselves and (2) the head of the household might have additional children in other homes (for example, the case of divorced but remarried parents). To address the first problem we included only households in which the head of the household is less than 55 years

old. This upper bound was used as a way to eliminate households in which the children may have already left the household.

Labor supply: To obtain the data concerning numbers of hours supplied to the labor market, we used the employment section of the survey which provides the number of hours worked by each individual in the labor force (and hence it includes unemployed individuals) during the week before the survey was taken.

Social security payroll tax: The section on employment provides information about the social security system to which the individual is affiliated. Using question 21 of the CASEN employment section, we were able to construct the tax rate paid per individual as a contribution to the social security system. The question is “Are you affiliated with any pension system?”. The possible answers are: (1) Social Security Administration, (2) Public Worker Pension Administration, (3) Private Worker Pension Administration, (4) Private system (AFP), (5) Armed Forces Pension System, (6) other, (7) not affiliated. The tax rates were indicated above for groups (1) to (5), while the group (7) does not pay any social security tax. The individuals that were affiliated with other social security institution – category (6) – are individuals that are affiliated with a PAYG institution other than (1), (2), (3) and (5). The average level of the tax rate imposed by those institutions was imputed to category (6).

Wage rate per hour and non labor income: The wage rate per hour of labor was constructed by dividing total labor income by total number of hours worked during the week before the survey was realized (both data are available from the employment section of the 1998 CASEN). The survey does not provide much data about non-labor income but, as it does provide data concerning government subsidies, we constructed non-labor income as the sum of governmental subsidies that were unrelated to employment status.

### **Some Preliminary Observations**

The survey provides some interesting information across social security systems. Firstly, it shows that among individuals aged 38 and older in 1998 – individuals who were of 22 years of age or more in 1981 when the law was introduced and hence individuals that were likely to have been labor force

participants in 1981– 41 per cent were not affiliated with any social security system, while 22 per cent of them were affiliated with the PAYG system and 37 per cent with the IA system. Thus this first observation indicates that among individuals allowed to self-select between systems, the fraction of individuals affiliated with the PAYG remains quite large.

Secondly, hours supplied to the labor market differ across the social security systems. The head of household who is affiliated with the IA system worked, on average, 52.4 hours per week whereas one affiliated with the PAYG system worked 51.4 hours. When we restrict the sample to female heads of households, we observe that, females in the individual account system worked 45.38 hours per week while females in the PAYG system worked only 43.88 hours.

Thirdly, the average number of children per households where the head of household was affiliated with the individual account system was 1.82, while in the PAYG system it was 1.18. This large difference might be explained by the fact that workers in the PAYG system are relatively older and hence it is more likely that their children have already left the household. To avoid the problem, we included heads of household older than 38 years – they could self select in 1981 – but younger than 55 years. In this case, as shown in Table 1, the average number of children in households where the head is affiliated with the PAYG was 1.98 while in the IA system or out of the system the numbers are 2.14 and 2.15, respectively.

These preliminary observations provide some evidence of the effect of the PAYG system on the fertility rate and labor supply. Additional summary statistics across social security systems are provided in Table 1.

[Insert Table 1 about here]

## **The Empirical Strategy**

We turn now to tests of the predictions made earlier concerning the fertility rate and labor supply. The way we proceeded was to estimate a linear relation between a variable of interest and the tax rate of

the social security system, plus additional variables. In the case of the fertility rate, we assumed a linear relationship as in equation (14):

$$n_i = \alpha_0 + \alpha_1 tax_i + \alpha_2 taxp_i + \beta X_i + \varepsilon_i \dots (14)$$

where  $i$  indexes head of household and  $n_i$  is the number of children per household. The variable  $tax_i$  is the social security payroll tax rate in the social security system, including a zero tax rate for individuals unaffiliated with any social security system, while the variable  $taxp_i$  is equal to the social security payroll tax rate if the individual is affiliated with the PAYG system and zero otherwise. Note that in this specification, the effect of the PAYG social security tax rate is  $\alpha_1 + \alpha_2$ . The matrix  $X_i$  contains a set of additional variables that might influence fertility rate. As the number of children per head of household might be censored at zero, we made both least squares-instrumental variable (LS-IV) estimates and Tobit-IV estimates.

When we consider labor supply, we hypothesize the following relationships:

$$h_i = \beta_0 + \beta_1 tax_i + \beta_2 taxp_i + \beta_3 w_i + \beta_4 ynl_i + \gamma X_i + u_i, \dots \text{if } \dots w_i > w_i^*(Z_i, e_i) \dots (15)$$

$$h_i = 0 \dots \text{if } \dots w_i \leq w_i^*(Z_i, e_i) \dots (16)$$

where  $h_i$  is the number of hours supplied to the labor market,  $w_i$  is wage rate per hour,  $ynl_i$  is non-labor income,  $w_i^*$  is the reservation wage,  $Z_i$  and  $e_i$  are a set of variables influencing the reservation wage. We assume that  $e_i$  is a random shock that is distributed normally. Accordingly, we estimated the following relationship (see Maddala, 1983):

$$h_i = \beta_0 + \beta_1 tax_i + \beta_2 taxp_i + \beta_3 w_i + \beta_4 ynl_i + \gamma X_i + \frac{\phi(Z_i)}{\Phi(Z_i)} + u_i \dots (17)$$

where  $\phi$ ,  $\Phi$  are the density and the cumulative function of the standard normal distribution. Equation (17) allows us to identify the uncompensated labor supply. The uncompensated wage effect,  $\beta_3$ , is ambiguous, while  $\beta_4 < 0$  would indicate that leisure is not an inferior good. Note that the substitution effect in this regression is measured by  $\beta_3 - h$ ,  $\beta_4 > 0$ .

The direct estimations of equations (14) and (17) pose an obvious problem: individuals might self-select between social security systems. When this selection process arises as a function of unobservable characteristics, summarized in the error terms  $\varepsilon_i$  in equation (14) and  $u_i$  in equation (17),  $\text{cov}(\text{taxpg}, \varepsilon) \neq 0$  and  $\text{cov}(\text{taxpg}, u) \neq 0$ . This problem invalidates the consistency of the estimates.

To address this problem, we pursued the following strategy. Firstly, we used a number of additional variables. The data set contains a large number of variables: (1) demographic (dummy variables were used for sex and marital status, age and age squared, labor income and location variables concerning the geographic location of the individual in Chile), (2) variables related to subsidies obtained from the Chilean government (variables particularly relevant to control for characteristics of poorer families), (3) health related variables (dummy variables indicating if the individual has been hospitalized during the last three months before the survey was made or indicating if the individual has been sick during that same period of time), and (4) variables relating to job characteristics (dummy variables indicating if the job is permanent, dummy variables for industry and dummy variables relating the type of work, e.g., blue collar or white collar).

Secondly, we exploited the properties of the 1981 reform law to control by self selection. We included in the analysis only individuals who were in the labor force in 1981 and hence could have self selected. To do so, we worked only with individuals who were 25 years old or more in 1981. We choose this sample because it allows us to eliminate the possibility of including individuals completing college degrees (in Chile the typical student graduates from college when 23 or 24 years of age). A problem with this sample, as was indicated above, is that the estimate might be inconsistent due to a potential correlation between the error term and the PAYG variables included as regressors. To resolve the problem, we required a set of instruments that were correlated with PAYG affiliation but exogenous to unobservable characteristics.

We chose as instruments some variables thought to have been highly influenced by the 1981 reform law and hence are exogenous to the individual decisions and uncorrelated with individuals' unobservable characteristics. The first instrument is a dummy variable equal to unity if the worker is

self-employed and zero otherwise. We use this variable because the law allowed self-employed workers to remain unaffiliated with any social security system. The second instrument is a dummy variable equal to unity if the individual worked in the public sector and zero otherwise; this variable is a proxy for affiliation with the Public Worker Pension Administration prior to 1981. This is relevant information because those workers had, on average, larger pensions than those in the PAYG system and therefore had less incentive to switch to the new system. Finally, we also included as instruments a dummy variable equal to unity if the individual was a member of the armed forces and zero otherwise, plus the age of the individual in 1981, which captures the age dependency in the switching decision between social security systems.

## **The Results**

Table 2 provides the results from the first stage of the instrumental variable approach. The R squared of that regression shows that the instruments explain a significant part of the variation in the PAYG tax rate. As expected, the sign of the dummy variable concerning the armed forces is positive, as those individuals must affiliate to a PAYG system. The dummy variable related to self-employed workers has a negative sign indicating that those individuals are less likely to affiliate. The age variable has a positive coefficient in the tax rate equation; older individuals were more likely to remain affiliated with the PAYG system.

[Insert Table 2 about here]

Table 3 presents the results for regressions concerning the number of children per household using the social security payroll tax in the PAYG system as an instrument. As noted above, we restricted the sample to heads of households between 38 and 55 years of age. We used this sample because it includes individuals who were in the labor force in 1981 but, additionally, the upper bound of 55 years of age was intended to exclude households which were unlikely to have children still in the household. The total number of observations was 16,399.

Column 1 of Table 3 reports the estimates by the LS-IV method, while column 2 presents the results using the Tobit-IV method. The effect of the PAYG social security payroll tax rate is close to -0.1. Accordingly, an increase of ten per cent in the PAYG social security tax rate would induce a decline of one child in the optimal number of children desired by a household.

The regression program offers tests for over identification of our instruments. As the reported critical values at the five and ten per confidence levels are always higher than the reported test values, it was not possible to reject the null hypothesis that the instruments do not belong in the fertility equation; the use of the instruments is strongly supported by the over identification test.

[Insert Table 3 about here]

Table 4.a presents the results for the Probit model used to construct the control variable  $\phi/\Phi$  and Table 4.b contains the results for the second stage in the case of regressions that include hours worked per week as a dependant variable. In the set of variables  $Z$  we included demographics, health related variables, location variables and other variables that might determine wage rate such as schooling and age. The dependent variable in the Probit was a dummy equal to unity if the individual was in the labor force (employed or looking for a job) and zero otherwise, and the sample was restricted to individuals aged 18 to 65 years. Table 4.a shows that health factors are the most relevant variables in determining whether the individual was in or out the labor force. Females and older individuals seem to be more likely to be out of the labor force; these variables, however, are not statistically significant.

Using the Probit, we constructed the control function and were able to estimate equation (17). Table 4.b presents the results using three different samples. In the three cases, we restricted our attention to individuals that were in the labor force in 1981 in order to be able to compare the response of labor supply across social security systems. The first sample uses the set of all individuals in the labor force in 1981. This sample was then decomposed into females and males in the second and third samples. In the three cases, the PAYG tax rate is significant and it negatively impacts labor supply, as expected. It is quite interesting to note that the negative effect is larger in the case of females, indicating that the females'



opportunity cost of labor supply is higher (it is possibly that their time is better spent bringing up children). The results indicate that an increase of ten per cent in the PAYG social security tax rate is associated with a decline of almost 1.5 hours of work per week for males and five hours of work per week for females (assuming that a full time job involves 48 hours of work per week). Also note that the social security tax in IA is insignificant and the coefficient is small in magnitude.

Concerning the other estimated coefficients of the labor supply function, note that the signs of the wage rate and non-labor income are negative, but the compensated elasticity of labor supply, e.g.,  $\beta_3 - h\beta_4$ , are positive as required<sup>7</sup>. Accordingly, we conclude that the labor supply is upward slopping and that leisure is a normal good. Finally, the control function is significant in all three regressions.

[Insert Tables 4.a and 4.b about here]

To examine the validity of the instruments, we note that, as shown in Table 2, the instruments are correlated with the social security tax, as required. Further, Tables 3 and 4.b provide tests for over identification of instruments with similar conclusions; we cannot reject the hypothesis that the instruments do not belong to equations (14) and (17). Thus we cannot reject the hypothesis that the instruments are valid.

In summary, the empirical findings from the Chilean experience show that the effect of the PAYG social security system might be quite large if when that system involves a 20 per cent tax rate. This system would be associated with a reduction of two children per household and nearly ten hours of work per week in the case of females and nearly three hours in the case of males.

#### ***IV. Are social security tax rates unit-root processes?***

The last section provided cross-sectional evidence using individuals' data of the effect of PAYG social security system over fertility rate and labor supply. In this analysis, we pooled time series data on social security taxes across countries to test if the PAYG social security tax rate has a unit root. As the

goal is to see if the social security tax rate follows a unit-root process, we constructed a proxy for this series of data for a set of OECD countries by taking data from the IMF International Financial Statistics. For each country we obtained (a) social security tax revenue as a fraction of all current revenues and (b) the current revenue of government, excluding grants, as a fraction of GDP. Hence as a proxy for social security tax rate, we divide (a) by (b) and we obtain social security taxes as a fraction of GDP. The series are annual data ranging from 1970 to 1999.

The criterion concerning choice of countries was basically to choose the OECD countries that currently have a typical PAYG system. This criterion eliminated countries such as France and the UK which have transformed their social security systems during the past 20 years. Also, as the data set contains missing observations, we focus on OECD countries with a number of data points equal to or larger than 19 observations during our period of analysis. The countries used in the analysis are Austria (AUS), Belgium (BEL), Canada (CAN), Denmark (DEN), Finland (FIN), Greece (GRE), Hungary (HUN), Iceland (ICE), Ireland (IRE), Israel (ISR), Italy (ITA), Korea (KOR), Luxembourg (LUX), Netherlands (NETH), Norway (NOR), Portugal (POR), Romania (ROM), Spain (SPA), Sweden (SWE) and the United States (USA). Figures 3 to 6 show the evolution of those tax rates over time. It is clear that, in general, there exists a clearly upward trend in the data with the sole exception of Greece, which shows a drop in 1990.

[Insert Figures 3 to 6 about here]

We first performed univariate ADF tests for unit roots in each of the series. The results are provided in Table 5. The regressions were run with a time trend and, as we were using annual data, the lag length was set equal to two. The critical values were computed using MacKinnon's (1990) method. The results show that we cannot reject a unit root process at the five per cent confidence level for any of the series (the calculated statistics are to the right of the critical values).

[Insert Table 5 about here]

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<sup>7</sup> The compensated elasticity of labor supply is approximately 2.3, assuming 48 hours of work per week.

A potential problem with this approach is that univariate unit root tests might have low power to reject the null hypothesis in small samples. To check the above results, we conducted a unit-root panel-based test.

We assumed that the social security tax rates follow the process:

$$\tau_{i,t+1} = \gamma_0 + \gamma_i + \nu_t + \gamma_1 * t + \gamma_2 \tau_{i,t} + e_{i,t} \dots (18)$$

where i indexes countries and t indexes time while  $\gamma_i$  is a country fixed effect and  $\nu_t$  is a time fixed effect.

Following Levin and Lin (1992) and Wu(1996), the model to be estimated (similarly to an ADF test) is:

$$\Delta \tilde{\tau}_{i,t} = b \tilde{\tau}_{i,t} + \sum_{j=1}^p \alpha_j \Delta \tilde{\tau}_{i,t-j} + \tilde{e}_{i,t} \dots (19)$$

where  $\Delta$  indicates first differences and  $\tilde{\tau}_{i,t}$  is a transformation of the data that allows us to remove the constant, the time trend, the country fixed effect, and the time fixed effect<sup>8</sup>. The interpretation of this test is similar to the one given to the ADF test. If the t statistic of the beta coefficient was less than the critical values, we rejected the null hypothesis of a unit-root process. If the t statistic was larger than the critical value, we accepted the null hypothesis.

The results appear in the lower part of Table 5, where we also report the critical values at the one and five per cent confidence levels. Those critical values were obtained from Wu (1996), which were computed using Monte Carlo simulations. The results indicate that we cannot reject the null hypothesis of a unit root in the social security tax at the confidence levels herein reported. Thus both tests – the univariate and the panel-based – indicate that the social security tax rate in the PAYG system follows a unit-root process.

## V. Conclusions

Financial crises are a current and common phenomena of the PAYG social security system around the world. This paper adds to the current debate about the future of PAYG social security systems; our maintained hypothesis is that the financial crises of those systems is endogenous. The result

relies on an endogenous demographic transition and a negative effect over labor supply that produce an upward trend in social security tax rates over time. The relationships between the tax rate and the demographic transition and labor supply create an explosive vicious circle in the PAYG system with the consequence that the PAYG system becomes unsustainable.

The paper provides supporting evidence through the use of a micro data base from Chile. The Chilean reform of its social security system in 1981 provides an adequate setup to obtain empirical evidence as we are able to compare the behavior of individuals unaffiliated with any social security system with individuals affiliated with the PAYG and with individuals affiliated with the IA system. Furthermore, evidence from several OECD countries with PAYG social security systems supports the hypothesis of a unit root in the PAYG social security tax rate. Thus the conclusion is that the implementation of a PAYG social security system is inevitably followed by higher social security tax rates through time, which are not possible to sustain due to obvious upper limits on that tax rate.

These results should be considered by policy-makers in the current debate concerning the future of the social security system. Any proposal to deal with the financial problem of the system must understand that partial reforms that retain the main structure of the PAYG system will only retard mayor reforms.

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<sup>8</sup> The transformation is the following:  $\tilde{\tau}_{i,t} = \tau_{i,t}^* - \tau_{i,t}^{**}; \tau_{i,t}^* = \tau_{i,t} - \frac{\sum_t \tau_{i,t}}{T}; \tau_{i,t}^{**} = \frac{\sum_i \tau_{i,t}^*}{N}$

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## Figures

Figure 1: Social security tax rate: Chile 1950-1980

Source: Arellano, J.P. (1985), "Políticas Sociales y Desarrollo: Chile 1924-1984"

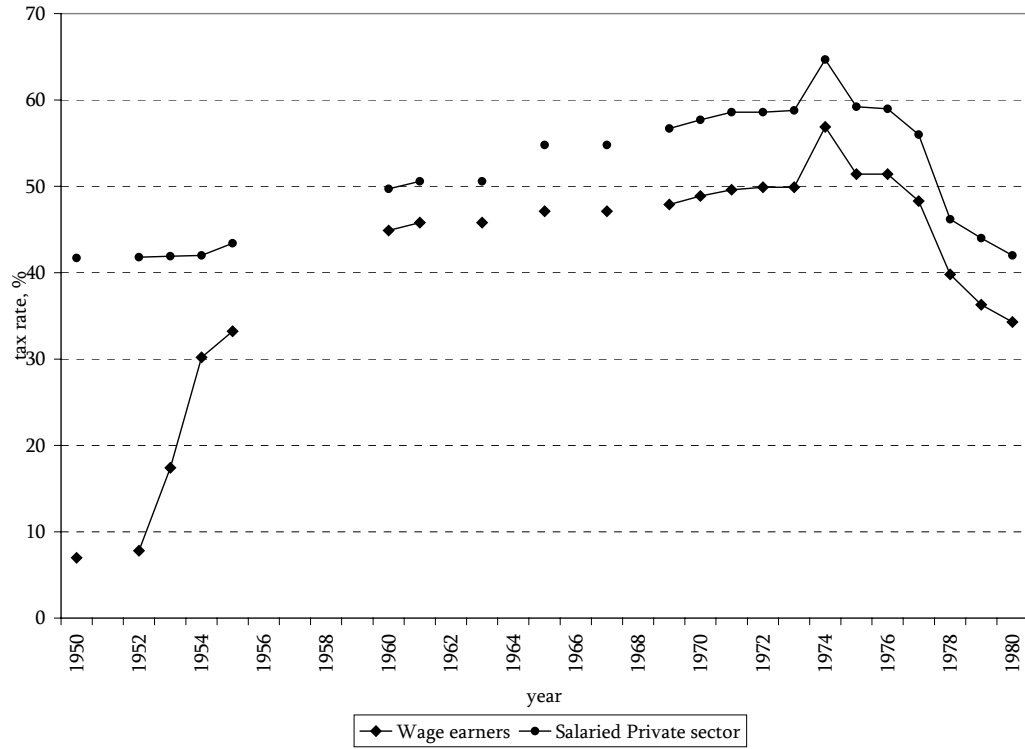


Figure 2: Fraction of individuals switching to the new system as function of age in 1981  
Source: Asociacion internacional de organismos supervisores de fondos de pensiones(1996), "Reforma a los sistemas de pensiones"

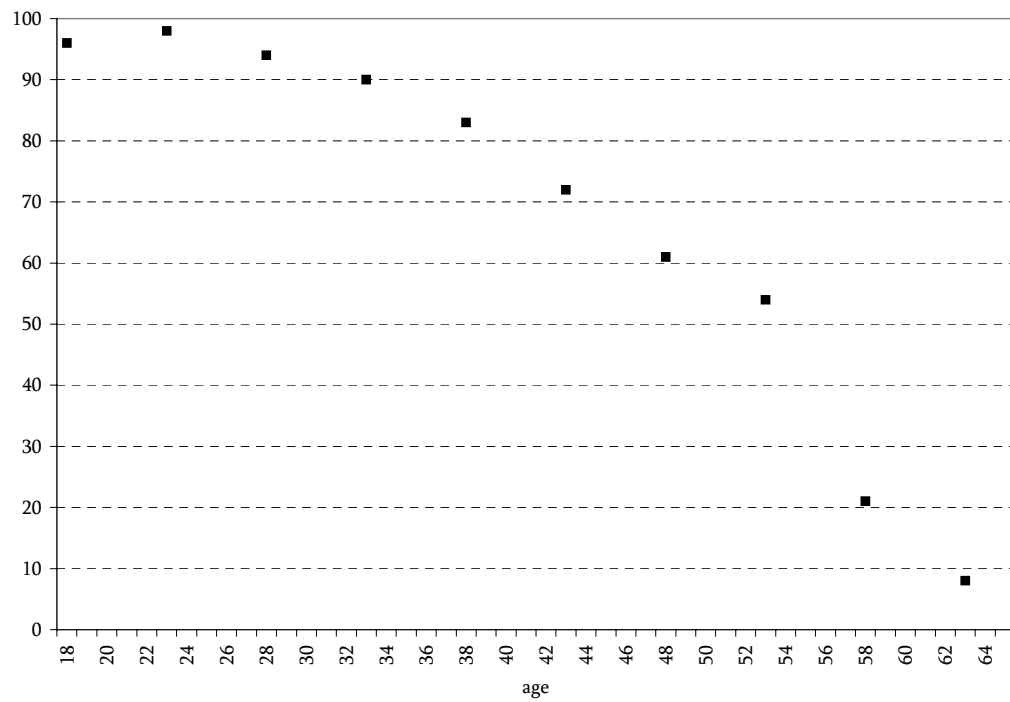


Figure 3: Social security tax as fraction of GDP

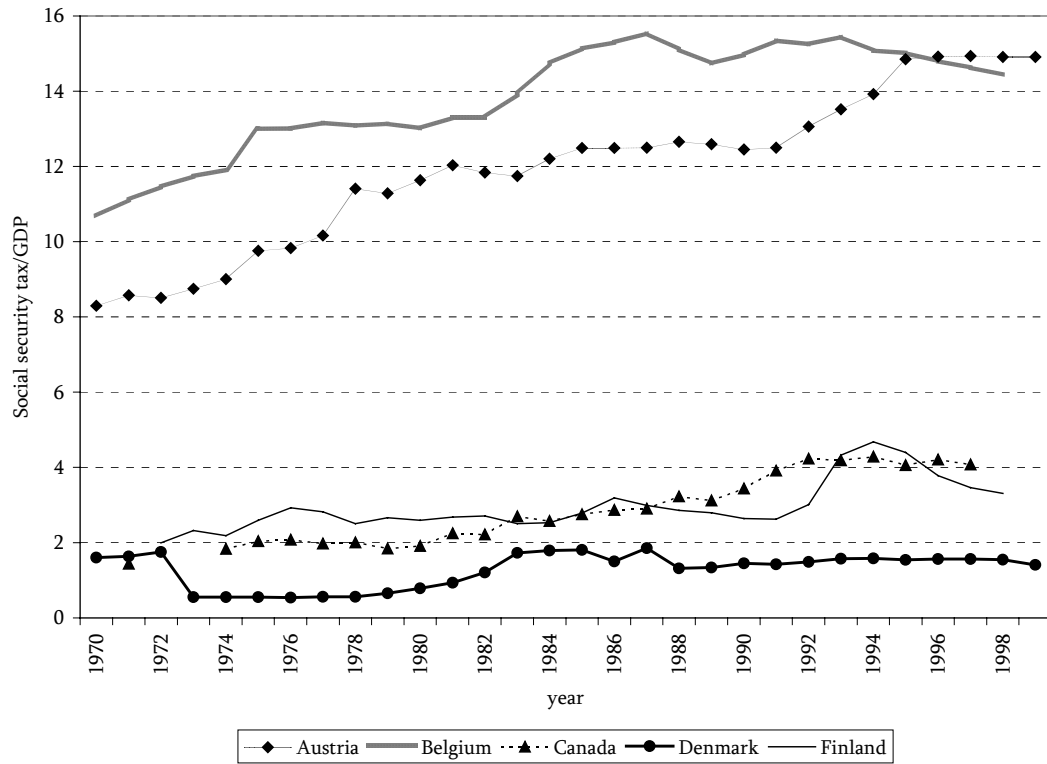


Figure 4: Social security tax as fraction of GDP

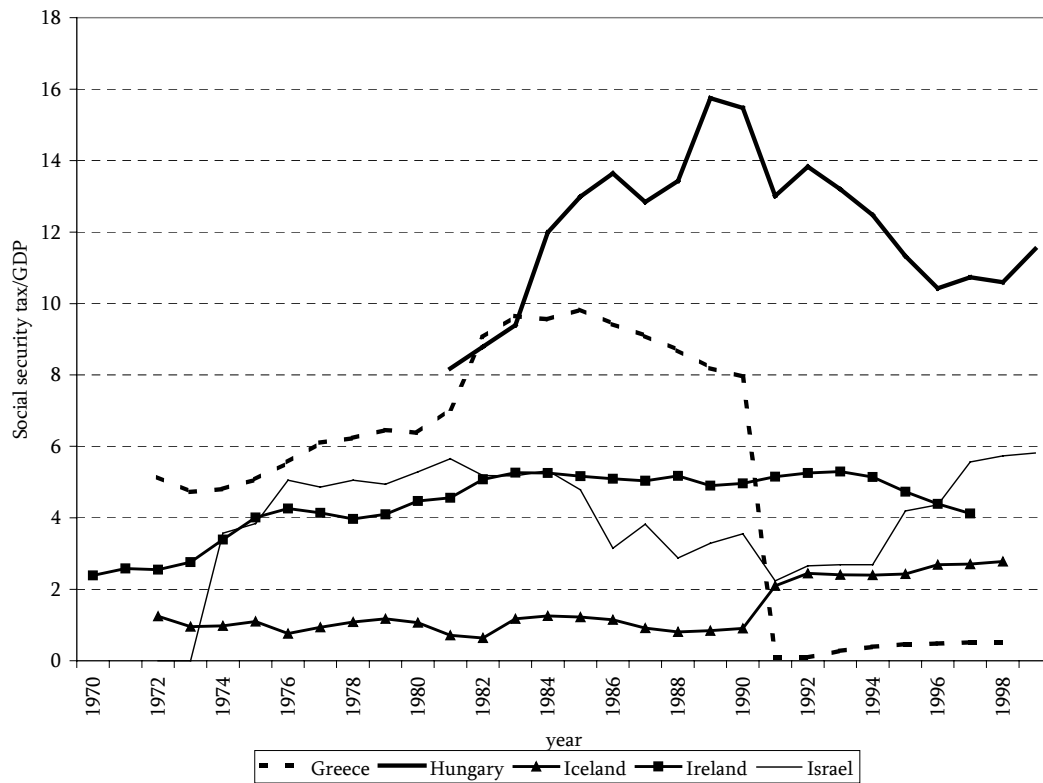


Figure 5: Social security tax as fraction of GDP

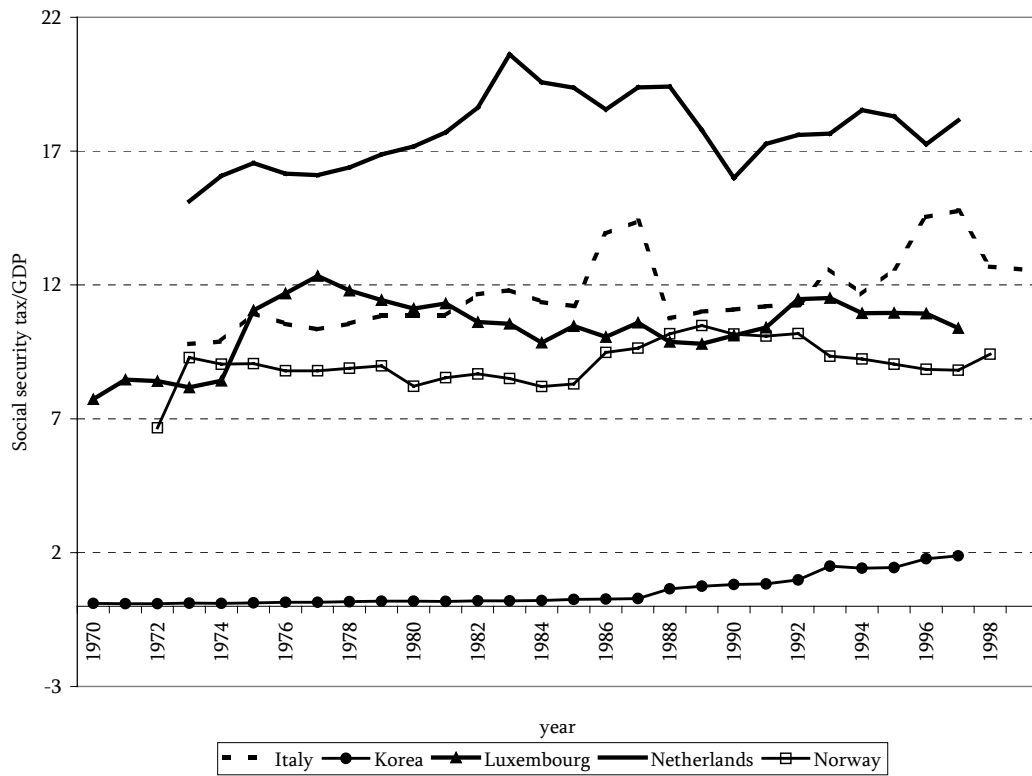


Figure 6: Social security tax as fraction of GDP

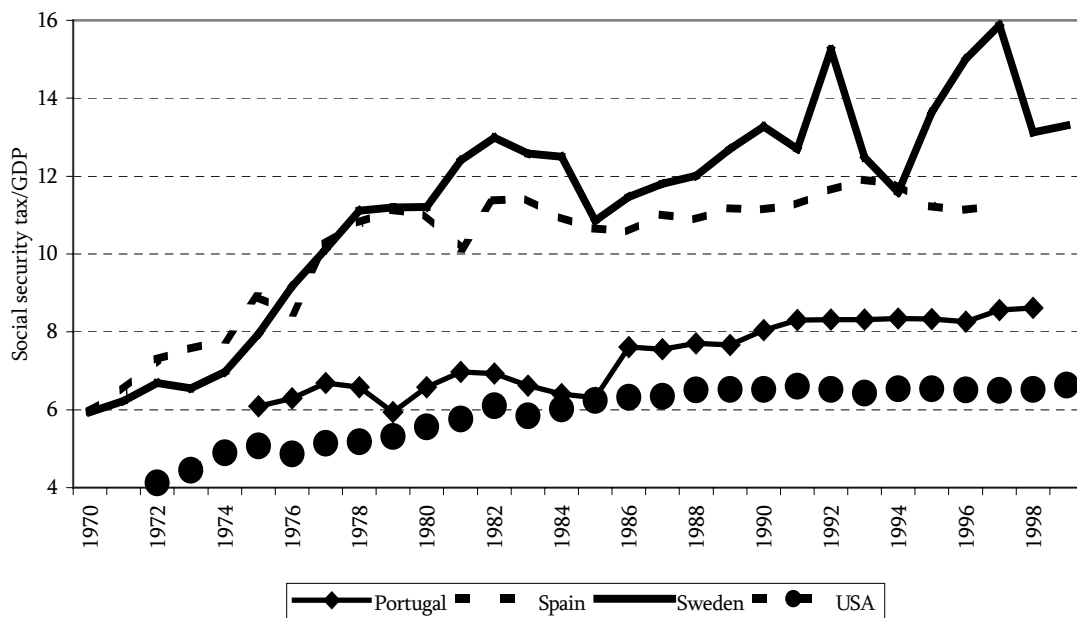




Table 1: Summary Statistics by Social Security Systems

		PAYG					IA(AFP)					Not Affiliated			
	Obs	Mean	St. Dev.	Min.	Max.	Obs	Mean	St. Dev.	Min.	Max.	Obs	Mean	St. Dev.	Min.	Max.
Children (per household)	10579	1.1899	1.27	0	10	24841	1.8282	1.2713	0	10	12687	1.6664	1.48	0	11
Hours worked	5657	47.43	18.99	0	112	42598	48.46	14.26	0	126	18434	44.54	19.61	0	126
Hours worked (female only)	1466	43.88	20.88	0	112	13449	45.39	14.67	0	126	6769	41.34	21.51	0	126
Tax rate*	15672	19.33	0.62	19.02	22.5	52561	10	0	10	10	55258	0	0	0	0
Individuals aged 22 or older in 1981															
Children (per household)	10110	1.16	1.27	0	10	13958	1.90	1.35	0	10	9408	1.58	1.51	0	11
Hours worked	4816	46.65	19.21	0	112	16769	48.51	14.92	0	126	8352	45.68	20.46	0	126
Hours worked (female only)	1242	43.20	21.33	0	112	4835	45.52	15.75	0	126	3159	42.84	22.54	0	126
Demographics															
Age	16476	61.16	15.67	18	99	52561	36.93	12.06	18	99	55258	39.56	17.05	18	99
Education(years)*	16323	7.79	4.22	0	19	52187	10.93	3.29	0	19	54927	9.21	3.79	0	19
Log of labor income *	6699	11.46	1.34	5.08	16.56	43355	11.89	0.84	5.08	17.70	19233	11.32	1.25	2.77	17.19
Married*	16476	0.61	0.48	0	1	52561	0.65	0.47	0	1	55258	0.58	0.49	0	1
Widow*	16476	0.20	0.40	0	1	52561	0.02	0.13	0	1	55258	0.06	0.23	0	1
Health															
Hospital attend.*	16476	0.35	0.47	0	1	52561	0.23	0.42	0	1	55258	0.34	0.47	0	1
Sickness*	16476	0.31	0.46	0	1	52561	0.18	0.38	0	1	55258	0.21	0.41	0	1
Individuals 37 to 54 years old															
Children	2065	1.98	1.39	0	10	10162	2.14	.131	0	10	4326	2.15	1.58	0	10
Hours worked	1513	48.65	19.76	0	112	9281	49.75	14.63	0	119	3288	47.5	19.57	0	112

Notes: The Table summarizes data from the 1998 CASEN survey ("Socioeconomic characterization of the Chilean population") which data was collected during November and December of 1998. In the Table "PAYG" means pay-as-you-go social security system and IA means individual account social security system. The variable Married and Widow are indicator functions equal to one if the individual is either married or widow and zero otherwise. The variable "Hospital attend." Indicates hospital attendance during the last three month before the survey while "Sickness" indicates if the individual was sick during any part of the three months before the survey was realized. When we use "\*", we mean that the sample restricted to individuals aged 18 and older. Finally note that "Individuals aged 37 to 54 years old" are individuals that could self-select between social security systems in 1981 for which we impose 54 years old as upper bound for age in 1998.

**Table 2: First Stage Regressions - PAYG Social Security Tax Rates**

	Social Security Tax Rate
1(self-employed)	-0.610 ** (0.045)
1(Army Forces)	17.522 ** (0.230)
1(Public sector)	-0.410 ** (0.088)
Age in 1981	0.157 ** (0.0007)
Constant	-1.102 ** (0.020)
R <sup>2</sup>	0.2539
F-Stat	12297.9
Prob(F)	0.0000
Observations	144522

Standard errors are in parenthesis. \*\*, \*\*\* mean significant at 5 and 1 per cent respectively. The function 1( ) is an indicator function equal to one if the condition is true and zero otherwise. The variable "self-employed" indicates self-employed individuals, "Armed forces" indicates individuals affiliated to the army forces and "Public sector" indicates individuals employed in the public sector.

**Table 3: The Effect of the Social Security System on Fertility Rates**

	LS	Tobit
Dependent Variable:	Number of children	Number of children
Tax rate	-.0099** (0.0029)	-0.0102** (0.0022)
Tax rate in PAYG (Instrumented)	-0.1063* (0.0560)	-0.1027** (.0403)
Other demographics	YES	YES
Subsidies	YES	YES
Health variables	YES	YES
R <sup>2</sup> -Pseudo R <sup>2</sup>	0.23	0.07
F-Stat (Chi <sup>2</sup> )	90.50	4006.47
Prob(F)-Prob(Chi <sup>2</sup> )	0.0000	0.0000
Observations	14557	14557
Censored observations (at zero).		(1871)
Over-identifying restriction test		
Chi <sup>2</sup>	609.72	358.48
Chi <sup>2</sup> critical value 10%	23554.8	23554.8
Chi <sup>2</sup> critical value 5%	23633.8	23633.8

(1) The sample contains head of households aged 37 to 55. Those individuals could self-select between social security systems as they were in the labor force in 1981. It also includes self-employed individuals who could choose to remain unaffiliated with any social security system. The upper bound in age was set to avoid households in which children had already left their parents' home. The Table uses the head of households to obtain results for the number of children per household.

(2) "Standard errors are in parenthesis while \*\*, \*\*\* mean significant at 5 and 1 per cent respectively. Tax rate is the tax rate in any social security system (thus it includes the tax rate in the PAYG and IA account system. We also impute a zero tax rate for individuals not affiliated to the social security system). Tax rate in PAYG is indicator function containing the values of the PAYG system if the individual is affiliated with the PAYG and zero otherwise. This variable is instrumented as shown in Table 2. "Other demographics" includes location variables, dummies for married and widow individuals, schooling and schooling-squared plus labor income. The category "Subsidies" includes a set of subsidies provided by the Chilean government to poor households. The category "Health variables" includes indicator functions for sick individuals and hospital attendance during the period of three month before the survey.

**Table 4a: Probit Method: Probability of Being in the Labor Force**

	1(labor force)
Age	0.0029 (0.0237)
Age squared	-0.00002 (0.0002)
Schooling	-0.0722 (0.0605)
1(female)	-0.1400 (0.1195)
1(sick last 3 months)	-0.6065** (0.066)
1(hospital last 3 months)	-0.3292** (0.0701)
Pseudo R-squared	0.083
Observations	14014
Prob > Chi-squared	0.0000

The sample contains individuals aged 18 to 64 years. Standard errors are in parenthesis. \*\*, \*\*\* mean significant at 5 and 1 per cent respectively. The function 1( ) is an indicator function equal to one if the condition is true and zero otherwise. The regression also includes other variables that might determine the wage rate such as demographic variables (indicator functions for married and head of households), geographic location and other schooling variables plus variables that might determine reservation wage such as asset holdings (indicator function for house ownership) and non-labor income.

**Table 4b: The Effect of Social Security Taxes on Labor Supply**

	LS	LS	LS
<u>Dependent Variable:</u>	Log Hours worked	Log Hours worked	Log Hours worked
		females	males
Tax rate	0.0010 (0 .0018)	0.0044 (0 .0039)	-0.0001 (0 .002)
Tax rate in PAYG (Instrumented)	-0.235 ** (0 .089)	-0.434 * (0. 193)	-0.1818 * (0.099)
Log(wage)	-0.272 ** (0 .0172)	-0.357 ** (0.034)	-0.2482 ** (0 .019)
Log(non labor income)	-0.0542** (0 .006)	-0.080** (0.013)	-0.0451** (0.0071)
Control function	8.754* (4.195)	13.89* (7.043)	11.04* (5.007)
Other demographics	YES	YES	YES
Health variables	YES	YES	YES
Job Characteristics	YES	YES	YES
R <sup>2</sup> -Pseudo R <sup>2</sup>	0.301	0.338	0.268
F-Stat (Chi <sup>2</sup> )	852.93	9.42	164.78
Prob(F)-Prob(Chi <sup>2</sup> )	0.0000	0.0000	0.0000
Observations	10056	2221	7835
<u>Over-identifying restriction test</u>			
Chi <sup>2</sup>	1701.78	1687.31	1588.91
Chi <sup>2</sup> critical value 10%	29250.6	29250.6	29250.6
Chi <sup>2</sup> critical value 5%	29338.6	29338.6	29338.6

The sample includes individuals that could self-select between systems. Standard errors are in parenthesis while \*, \*\* mean significant at 5 and 1 per cent respectively. The variable Tax rate is the tax rate in any social security system (thus it includes the tax rate in the PAYG and IA account system. We also impute a zero tax rate for individuals not affiliated to the social security system). The tax rate in PAYG is an indicator functions containing the values of the PAYG system if the individual is affiliated with the PAYG and zero otherwise. Those variable are instrumented as shown in Table 2. "Other demographics" includes location variables, dummies for married and widow individuals, schooling and schooling-squared. The category "Health variables" includes indicator functions for sick individuals and hospital attendance during the period of three month before the survey. Finally, the category " Job Characteristics" includes indicator functions for full-time and part-time jobs, plus indicator functions for employees, employers and family members employed in the family's business.

**Table 5: Univariate and Panel-Based Unit Root Tests**

Univariate Test(ADF)	1% Critical Value	5% Critical value	ADF Test Statistic
AUS	-4.33	-3.58	-2.12
BEL	-4.35	-3.59	-1.09
CAN	-4.46	-3.64	-3.10
DEN	-4.33	-3.58	-3.90
FIN	-4.39	-3.61	-3.06
GRE	-4.39	-3.61	-1.65
HUN	-4.67	-3.73	-2.76
ICE	-4.39	-3.61	-1.71
IRE	-4.37	-3.60	-0.92
ISR	-4.37	-3.60	-1.59
ITA	-4.39	-3.61	-2.32
KOR	-4.37	-3.60	0.22
LUX	-4.37	-3.60	-2.73
NETH	-4.44	-3.63	-1.55
NOR	-4.39	-3.61	-2.13
POR	-4.46	-3.64	-2.81
SPA	-4.37	-3.60	-1.71
SWE	-4.33	-3.58	-1.94
USA	-3.72	-2.98	-2.49
Panel-based test	-7.629	-7.025	-6.85

The sample was selected among OECD countries with PAYG social security system during the period 1970-1999 and for which the number of observations was at least 19. We report different critical values because the size of the sample is not the same for each country. The critical values of the univariate tests correspond to MacKinnon (1990). The panel test for unit root here presented is the one proposed by Levin and Lin (1992), and Wu (1996). The critical values are from Wu(1996).